Coherent X-ray Diffraction Microscopy with High Precision Aperture

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Small apertures are often necessary in coherent x-ray diffraction microscopy for illuminating small areas around the small samples. However, it is extremely difficult to fabricate hard x-ray pinholes with the diameter of smaller than 10 μm with sufficient precision. High precision cross slits, composed of four tantalum polished blades, were fabricated by TDC Corp., Sendai, Japan. The cross slits had the width of 10~20 μm (width down to 1 μm is possible). We believe that precise aperture will enable us to minimize the noise in the coherent X-ray diffraction microscopy.

Coherent X-ray diffraction microscopy was performed using 9 keV x-rays by taking the Fraunhofer diffraction pattern of the cross slit by the downstream image detector. Experiment was done at about 80 m from the light source of BL29XU/SPring-8 with well reduced upstream slit sizes. Fraunhofer patterns from the aperture included negligible scattering from the edges of the aperture. By placing various samples very close to the aperture, the complex transmissivity of the samples was also measured. The distance from the aperture to the sample and to the imaging detector was chosen to be approximately 3 mm and 4.3 m. Phosphor coupled CCD camera with the effective pixel size of 4.5 μm (Hamamatsu Photonics Corp., Japan) was used as the image detector. We have succeeded in retrieving the complex transmissivity of thick objects (e.g. distributed 8 μmϕ latex particles corresponding to 1/5 λ phase shift). Difference map algorithm was applied to a single diffraction pattern. For objects with complex transmissivity, we have found that the difference map algorithm is more powerful than the HIO algorithm.